# A SEAS CHANGE

## Groundbreaking computational models aid in behavioral simulations

In 2001, Afghanistan was one of the poorest nations in the world, with little infrastructure and a failing economy. After decades of conflict and years of repression by the Taliban, its population faced a growing refugee crisis. As led by the United States, a number of international government agencies and non-governmental organizations (NGOs) began stepping in to offer aid and assistance. Many of these efforts, however, were hampered by significant challenges, including a lack of local knowledge and corruption on the side of Afghan government officials.

In relief environments like Afghanistan, a company founded on cutting-edge management and computer science research from Purdue University saw the opportunity to help. Simulex, Inc. was created in order to build large-scale simulated virtual worlds, allowing users to anticipate problems that might arise in environments like Afghanistan. Through a platform called Synthetic Environments for Analysis and Simulation (SEAS), Simulex helps model complex scenarios in a nation like Afghanistan in order to shape policy choices. Real-world data and theories on organizational/human behaviors mold the artificially intelligent virtual agents in SEAS, which include individuals, organizations, institutions, and infrastructure.

"Essentially, we create computational models of human behavior," said Simulex founder Dr. Alok Chaturvedi, who is also a professor in Purdue's Krannert Graduate School of Management. "We combine open-source data with theories from different disciplines of social science to model behaviors of people and societies. We did a lot of work on the Middle East, like Iraq and Afghanistan, and we worked closely with Homeland Security."

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Simulex's virtual Afghanistan is represented by 47,000 citizen agents, 19,000 refugee agents, 208 infrastructure agents, 17 organizations, 29 leaders, and 2 institutions. Once created, Chaturvedi and his colleagues tested various intervention plans for reconstruction and stability operations, humanitarian aid and assistance, finding that a minimalist approach to reconstruction efforts would prove more effective than a maximalist approach.

The SEAS technology enables researchers and organizations to test out strategies in a realistically detailed environment without risk. It can run real-time simulations for 62 nations, incorporating data from breaking news, census records, economic indicators, and climatic events, along with proprietary information such as military intelligence. The technology has been used by the U.S. Joint Forces Command, Naval Air Command, U.S. Army Recruiting Command, and Fortune 500 companies for analysis, planning, and training.

Simulex, founded in 1999, received a series of four contracts via the Department of Defense's (DoD) Small Business Innovation Research (SBIR) program, consisting of Phase I, II, and III awards from the Navy, and a follow-on Phase II from the Air Force, which expanded the applications of SEAS to the military. The West Lafayette, Indiana-based company has worked closely with the DoD to predict battle outcomes in Iraq, to replicate domestic terrorist attacks, and to envision the long-term implications of troop recruitment efforts.

"The SBIR funding from the Navy was tremendously helpful. It helped us develop the idea further and opened the doors to the DoD," said Chaturvedi. "Before the SBIR contract, we were working on mostly research and commercial applications of

SEAS."

Chaturvedi, who has a background in management information systems and computer science, joined Purdue University 30 years ago as an assistant professor in the Krannert Graduate School of Management. His research focused on agent-based modeling, which simulates the actions and interactions of autonomous agents (e.g. people, organizations, etc.) to assess their effects on the system as a whole.

One of Chaturvedi's experiments simulated the health of a refugee camp over time and how to best administer humanitarian aid. Each refugee agent in the model was labeled with states like healthy, sick inside the medical center, or sick outside the medical center. The probability that a given agent would become sick depended on input variables like food/water, medical resources, and sanitation. Chaturvedi and his colleagues also input health data collected by the United Nations Refugee Agency.

Dr. Alok Chaturvedi

Users of the software can toggle the levels of input variables to determine which type of assistance would have the greatest benefit on overall refugee health. As food/water approaches low levels, for instance, sanitation has a bigger effect on the number of sick refugees. Such results suggest that humanitarian organizations should focus on improving camp sanitation conditions.

"Policy simulations are valuable because of their ability to facilitate risk reduction by providing training and feedback where mistakes are not fatal," Chaturvedi said.

Chaturvedi noticed a high demand for computational models like SEAS from various government and business organizations he spoke with. He decided to commercialize his research. Since then, the technology has run simulations for Homeland Security, labor markets, insurgency, war games, and many other scenarios.

The Iraq and Afghanistan virtual models from Simulex have grown in size and complexity over the years, and today they each possess about five million individual agents representing people, hospitals, mosques, etc. It has also been used by Fortune 500 companies like Eli Lilly, Lockheed Martin and many other consumer facing companies to forecast the outcomes of business scenarios, future industry landscapes, and where firms will stand against their competitors.

In 2005, SEAS was recognized by the National Training Simulations Association (NTSA) as the best simulation for analysis in all of the DoD. That same year, the governor of Indiana awarded Chaturvedi the state's highest civilian award for his services to the state, naming him the "Sagamore of the Wabash" for 2005, using a term borrowed from the Algonquin-speaking American Indian tribes for an honored chieftain or wise sage. Two years later, Chaturvedi received Purdue University's 2007 Outstanding Commercialization Award in recognition of his role in the development of SEAS.

Although he sold SEAS to another company in 2013, Chaturvedi's technology remains operational and in use. SEAS is widely employed by Fortune 500 companies, local and state governments, and the U.S. Department of Defense for experimentations, planning, analysis, operations, and shaping for complex problems.

"Even though we call this 'war-gaming,' we're trying to understand how we can all work together to make the world a more peaceful and prosperous place," Chaturvedi said. "We focus on the political, social, and economic aspects of other cultures in our exercises. As we realize our weaknesses and strengths when it comes to understanding the motives and reactions of these cultures, we put ourselves in a better position to achieve peace."

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**Simulex, Inc.** • West Lafayette, IN

Modernization Priority: Artificial Intelligence (AI)/Machine Learning (ML)

SBIR contracts: N00024-07-C-4115 and FA8650-12-C-1477 • Agencies: Navy and Air Force • Topic: N05-047, Methods to Assess Technology Insertion Impact and Optimized Manning